Original Article

Thoracic combined spinal epidural anesthesia for laparoscopic cholecystectomy: A feasibility study

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Abstract

Background and Aims: The use of regional anesthesia for laparoscopic cholecystectomy has been reserved for patients who are at high-risk under general anesthesia (GA). The aim of this study was to assess whether thoracic combined spinal epidural (CSE) anesthesia is a feasible option for American Society of Anesthesiologists (ASA) physical status I and II patients undergoing elective laparoscopic cholecystectomy.

Material and Methods: Thirty ASA physical status I and II patients undergoing elective laparoscopic cholecystectomy received thoracic CSE anesthesia at T9-T10 or T10-T11 interspinous space using the midline approach. Two ml of isobaric levobupivacaine 0.5% with 25 μg of fentanyl was given intrathecally.

Results: Surgery was conducted successfully in all except one patient. Thoracic CSE was performed at T9-T10 interspace in 25 patients and T10-T11 interspace in five patients. Paresthesia occurred in two patients (6.6%) transiently on Whitacre needle insertion that disappeared spontaneously. Dural puncture on epidural needle insertion occurred in one patient, and intrathecal placement of epidural catheter occurred in one. Ten patients (33%) complained of shoulder pain. Conversion to GA was done in one patient due to severe shoulder pain and anxiety. Hypotension occurred in 11 patients (36%) and all responded to single dose of mephenteramine 6 mg and fluid bolus. Bradycardia occurred in six patients (20%) which was managed in all with a single dose of atropine.

Conclusion: Thoracic CSE anesthesia can be used effectively for ASA I and II patients undergoing laparoscopic cholecystectomy with significant postoperative benefits.

Key words: Laparoscopic cholecystectomy, levobupivacaine hydrochloride, regional anesthesia, thoracic combined spinal epidural anesthesia

Introduction

The optimal treatment for patients with symptomatic cholelithiasis is elective laparoscopic cholecystectomy.[1] Laparoscopic surgeries are commonly performed under general anesthesia (GA) and endotracheal intubation to prevent aspiration and respiratory embarrassment secondary to induction of pneumoperitoneum. Regional anesthesia has been surprisingly reserved for patients who are at high-risk while under GA.[2] Thoracic epidural anesthesia has been used in laparoscopic cholecystectomy in healthy patients almost exclusively in combination with GA in order to extend the analgesic effect during early postoperative period.[3] Studies of spinal anesthesia either alone or combined with epidural approach performed at lumbar level for laparoscopic cholecystectomy have been performed successfully.[4] The aim of this study was to assess whether thoracic combined spinal epidural (CSE) anesthesia is a feasible option for American Society of Anesthesiologists (ASA) physical status I and II patients undergoing elective laparoscopic cholecystectomy.

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Material and Methods

After obtaining approval from the Institutional Ethics Committee, the present study was conducted on 30 ASA I and II patients undergoing elective laparoscopic cholecystectomy between November 2013 and January 2014. Written

informed consent was obtained from all participants. The inclusion criteria were, any ASA I and II patient undergoing elective laparoscopic cholecystectomy between the age 18 and 65 years. The exclusion criteria were any contraindication for spinal or epidural anesthesia, body mass index (BMI) >30 kg/m^2, acute cholecystitis, acute cholangitis, acute pancreatitis, suspected common bile duct stones, obstructive jaundice and patients with allergy to the study drugs.

Every patient underwent preanesthetic check-up 1 day prior to surgery that included a detailed history, complete general physical and systemic examination and relevant investigations. Patients were given midazolam 7.5 mg, pantoprazole 40 mg and domperidone 10 mg via the oral route at bedtime on night prior to surgery and were kept fasting 8 h prior to surgery. Patients were informed about CSE in detail and assured that any anxiety, discomfort or pain during surgery would be dealt with by intravenous medication and about the probability of conversion to GA, if needed. All patients were explained about pain scoring on the verbal response score (VRS; 0: No pain and 10: Worst possible pain) and scoring of symptoms (discomfort, nausea and vomiting, urinary retention, headache, and other neurologic sequelae) (0: Nil; 1: Mild; 2: Moderate; 3: Severe). Similarly, the surgeons were preinformed to ask for GA if they felt that the anesthetic technique is adding to the technical difficulty of the procedure.

In the preoperative room, an 18 gauge intravenous catheter was secured and preloading with Ringer lactate 10 ml/kg over 30 min was done, ondansetron 0.1 mg/kg intravenously and 40 mg of pantoprazole intravenously were given. In the operation theater, noninvasive blood pressure (BP), pulse oximetry (oxygen saturation [SpO_2]), end-tidal carbon dioxide ($EtCO_2$) and electrocardiography were started. Baseline values of heart rate, systolic BP (SBP), diastolic BP, mean arterial pressure (MAP), respiratory rate, $EtCO_2$ and SpO_2 were recorded. Midazolam 1 mg was given intravenously to every patient just prior to the start of the procedure in order to allay anxiety and apprehension. CSE was performed in the sitting position with a midline approach at the T9-T10 or T10-T11 interspinous space using a Portex CSE set that contains 18 gauge Tuohy epidural needle, 27 gauge Whitacre spinal needle and an epidural catheter. The epidural space was identified using the "loss of resistance" to air method, the distance from skin to epidural space being calculated from the length of the needle protruding from the skin. After entering the epidural space, a 27 gauge pencil point Whitacre spinal needle was advanced through the Tuohy needle until the resistance of the dura mater was felt, allowing the measurement of its distance from the tip of Tuohy needle. The dura was then pierced and the two needles secured together by a locking device that ensures that the spinal needle does not move any further beyond the tip of the Tuohy needle. After confirming free and clear flow of cerebrospinal fluid 2 ml of preservative free isobaric levobupivacaine 0.5% + 25 μg (0.5 ml) of fentanyl was injected and then the spinal needle was removed. The epidural catheter was then threaded into place, and fixed at 4 cm within the epidural space. Immediately after fixing the epidural catheter, the patients were made to lie in the supine position and oxygen at 4 l/min was given by face mask. Diverting type $EtCO_2$ monitoring system was used, using nasal prongs applied inside the face mask. Once the desired sensory block, that is T4-T12 as assessed by pinprick was achieved, surgery was commenced. Motor block was assessed using modified Bromage scale at the same time.

If the sensory block was inadequate even after 30 min, conversion to GA was done.

Intraoperative anxiety was treated with midazolam 1 mg intravenous boluses up to a total of 5 mg. Referred shoulder pain following pneumoperitoneum was treated with reassurance and fentanyl 25 μg intravenous boluses up to a total of 100 μg. Hypotension (fall in SBP <90 mmHg or decrease in MAP more than 20% from baseline value) was treated with mephenteramine 6 mg boluses and fluid bolus of 10 ml/kg; Ringer lactate and bradycardia (heart rate below 20% of baseline) with atropine 10 μg/kg intravenous boluses.

The surgical technique was modified to use lower levels of intra-abdominal pressure <10 mmHg. The flow rate of CO_2 administration was maintained at <2 l/min. A nasogastric tube was inserted only on surgeon demand. Operative difficulty or surgeon satisfaction was assessed by asking surgeons to score the operative conditions on a scale of 1-10 (1: Worst operative condition, 10: Best possible operative condition).

The epidural catheter was removed the next morning. Until then postoperative analgesia as and when required (VRS >3) was provided with 8 ml of 0.125% levobupivacaine as epidural top up.

The follow-up of patients after discharge was done telephonically on 3rd and 7th postoperative day, to inquire about postdural puncture headache (PDPH), any neurological deficit/symptom or any other complication. Patient satisfaction at follow-up was inquired on day 7 and was scored as unsatisfactory, satisfactory, very good and excellent.

Results

Thirty patients [Table 1] undergoing elective laparoscopic cholecystectomy were recruited in 3 months, none of the patients withdrew from the study and there was no conversion

to open cholecystectomy [Table 2]. Thoracic CSE block was performed at T9-T10 interspace in 25 patients and T10-T11 interspace in five patients. In five patients, a second attempt was required for insertion of epidural needle whereas the spinal needle could be inserted in the first attempt in all the thirty patients. The epidural catheter could be introduced easily in all the patients. Paresthesia occurred in two patients (6.6%) transiently on Whitacre needle insertion that disappeared spontaneously without any change in needle position. Dural puncture on epidural needle insertion occurred in one patient, and intrathecal placement of epidural catheter occurred in one.

The peak block height reached was up to T2, within 8-12 min (mean 8.3 min) and target level of T4 was achieved in all in a mean time of 7.3 min. Lower level (segmental blockade) ranged from L1 to S2. Motor blockade achieved was modified Bromage 1 (inability to raise extended legs/can bend knee) in 15 patients, modified Bromage 2 (inability to bend knee/can flex ankle) in nine patients and modified Bromage 3 (complete paralysis/no movement) in six patients. Sensory blockade regressed to T12 in a mean time of 137min, ranging from 115 to 160 min. Motor block regressed to modified Bromage 0 (full movement) in a mean time of 159 min, ranging from 130 to 185 min [Table 3].

Intraoperatively, epidural anesthesia was not required in any patient. Nasogastric tube insertion was required in one patient for deflating stomach. Mean duration of surgery was 35.5 min ranging from 23 to 55 min. During the procedure, ten patients (33%) complained of shoulder pain that was managed successfully in nine patients with injection fentanyl 50 μg. Conversion to GA was done in one patient due to severe shoulder pain and anxiety. Midazolam (2 mg) had to be given in six patients (20%) for allaying anxiety. All 29 patients remained conscious throughout the surgery with no respiratory depression and none complained of any dyspnea. None of the patients showed rise in $EtCO_2$ level more than 20% from baseline, but 12 patients (40%) showed rise in respiratory rate of >20% from baseline.

Hypotension occurred in 11 patients (36%) and all responded to a single dose of mephenteramine 6 mg and fluid bolus. Bradycardia occurred in six patients (20%), which was managed in all with a single dose of atropine [Table 4].

Postoperatively three patients had mild shoulder discomfort that subsided with reassurance and shoulder massage. No patient complained of any postoperative nausea or vomiting. No patient had urinary retention, and no PDPH was seen.

Table 1: Demographics

Characteristic	Observation
Sex	
Male:female	15:15
Age (years)	45 (20-64)
ASA	
I:II	17:13
BMI	26 (19-29)
Height	170 (158-182)

BMI = Body mass index, ASA = American society of anesthesiologists

Table 2: Characteristics in perioperative period

Parameters	Results
Duration of surgery	35.5 min (mean) 23-55 min (range)
Shoulder pain (*n*) (%)	10 (33)
Anxiety (requiring midazolam) (%)	6 (20)
Conversion to GA (*n*)	01
Conversion to open cholecystectomy	0
Hypotension (%)	11 (36)
Bradycardia (%)	06 (20)
Fluids given intraoperatively	1700 ml (mean) 1350-2100 ml (range)

GA = General anesthesia

Table 3: Characteristics of thoracic spinal anesthesia in the studied cases (*n* = 30)

Characteristic	Observation
Paresthesia from spinal needle insertion (%)	02 (6.6)
Peak sensory level	T2-1 (*n*)
	T3-7
	T4-22
Time to target level T4	7.3 min (mean)
	6-12 min (range)
Modified Bromage 1:2:3	15:09:06 (*n*)
Lower level (segmental blockade)	L1-5 (*n*)
	L2-8
	L3-6
	L4-6
	L5-2
	S1-2
	S2-1
Sensory blockade regression to T12	137 min (mean)
	115-160 min (range)
Motor block regression to modified Bromage 0	159 min (mean)
	130-185 min (range)

The patients required epidural analgesia mean 3.5 times (range 3-6) and the verbal response score in the first 24 hours was noted. Twenty-nine patients gave satisfaction score excellent and one patient scored it as unsatisfactory. Surgeons reported there was good muscle relaxation and operative conditions were comparable to GA and gave a satisfaction score >8 (excellent) in all thirty patients. All patients were discharged from the hospital 24 h after surgery, after removal

Table 4: Hemodynamics

Time (min)	Mean±SD		
	Heart rate	SBP	DBP
Baseline	80.4±8.8	134.1±12.6	78.8±7.9
2	79.8±8.9	127.3±12.1	75.3±8.2
4	77.3±9.2	121.7±13.5	71.1±9.6
6	75.6±10.4	115.7±11.3	67.1±9.0
8	74.0±12.0	115.0±11.5	65.0±9.0
10	73.1±10.7	118.9±12.8	67.1±9.1
15	72.5±10.4	119.9±11.0	68.5±7.2
20	73.4±10.7	121.7±10.7	69.5±5.6
25	72.8±10.5	121.5±8.5	70.9±6.4
35	73.5±9.8	121.2±9.5	70.8±7.1
45	73.9±8.9	122.2±8.3	70.9±6.6
55	74.13±9.3	124.2±9.5	72.2±5.7
65	75.8±9.4	125.6±9.1	72.2±5.4
75	76.4±8.5	127.1±8.8	73.1±5.3

SBP = Systolic blood pressure, DBP = Diastolic blood pressure, SD = Standard deviation

Table 5: Postoperative period

Characteristic	Observation
Surgical complications	0
Analgesia requirement	3.5 (3-6) (epidural top-ups)
Opioid requirement	0
Postoperative pulmonary complications	0
PONV	0
Ambulation: Day 0:1	30:0
Discharge from hospital day 1:2:3	30:0:0
Patient satisfaction score	29-excellent
	01-unsatisfactory
Surgeon satisfaction score	>8 (excellent) in all 30 patients

PONV = Postoperative nausea and vomiting

of epidural catheter and assessment of any neurological deficit, which was not seen in any patient [Table 5].

Discussion

Our study confirms an effective use of combined thoracic spinal epidural anesthesia in ASA 1 and II patients undergoing laparoscopic cholecystectomy with significant postoperative benefits as also described by Tzovaras *et al.*[4]

The safety of giving thoracic spinal anesthesia has been established by many clinical and radiological studies. Imbelloni *et al.*[5] studied the anatomy of the thoracic spinal canal with magnetic resonance imaging (MRI) in 50 patients. The space between the duramater and spinal cord in the thoracic region measured with MRI was 5.19 mm at T2, 7.75 mm at T5, and 5.88 mm at T10. The angle of entry almost 50° further elongates the distance from the tip of the needle to the posterior surface of the cord. Furthermore, use of a CSE system that limits the length of spinal needle which can project beyond the tip of the epidural needle also minimizes the risk of contact with neural tissue. The sitting position for neuraxial block further increases margin of safety as shown by Lee *et al.*, who found that in a head-down sitting posture, the posterior separation of the duramater and spinal cord is increased.[6]

The studies of van Zundert *et al.*[7] and Imbelloni *et al.*[8] further support the safety of administering thoracic spinal anesthesia. Imbelloni *et al.* performed thoracic spinal at T10 in 300 patients safely, incidence of paresthesia in his study was 6.6%, without any permanent neurological damage.

We chose CSE over spinal anesthesia in view of safety concerns, the ability of epidural catheter to extend the block level in cases of prolonged surgery or inadequate blockade and better postoperative analgesia. Use of perioperative epidural anesthesia and analgesia, especially with a local anesthetic-based analgesic solution, can attenuate the pathophysiologic response to surgery and may be associated with a reduction in mortality and morbidity when compared with analgesia with systemic (opioid) agents.[9] Moreover, randomized clinical trials have demonstrated that use of postoperative thoracic epidural analgesia with a local anesthetic-based analgesic solution allows earlier return of gastrointestinal function and fulfillment of discharge criteria.[10] Considering that the mean duration of surgery was 35.5 min (ranging from 23 to 55 min) one would assume that spinal anesthesia would be adequate for laparoscopic cholecystectomy but due to the more controlled penetration of spinal needle beyond epidural space with needle through needle technique we recommend CSE system to be used. In another study Imbelloni *et al.*,[11] administered 1.5 ml hyperbaric bupivacaine + fentanyl 20 μg intrathecally at T10-T11 intervertebral space. After placement of the subarachnoid block, patients were placed in a 20-30° Trendelenburg position to achieve desired height for laparoscopic cholecystectomy. We avoided making Trendelenburg position by increasing the volume of drug (2 ml).

We had transient paresthesia in two patients without any neurological deficit. Dural puncture during epidural catheter insertion occurred in one patient, but this complication is not specific to thoracic technique.

Laparoscopy-related referred right shoulder pain, principally attributed to diaphragmatic irritation from CO_2 pneumoperitoneum is a well-known phenomenon.[12] Shoulder pain in our patients was mild and tolerable, and did not necessitate conversion of anesthetic technique in nine of ten patients. Our incidence of intraoperative shoulder pain similar to the 25% found by Zundert *et al.* In contrast, Tzovaras *et al.* reported a 43% incidence in patients who underwent

laparoscopic cholecystectomy under lumbar spinal anesthesia. Shoulder pain after laparoscopic cholecystectomy also occurs in 30-50% patients given GA.[13]

We chose a low-pressure pneumoperitoneum at a maximum of 10 mm Hg of intra-abdominal pressure to minimize diaphragmatic irritation as well as abdominal and respiratory discomforts.[14,15] This did not compromise the adequacy of surgical space and vision. All the procedures were completed with minimal technical difficulty, probably due to better muscle relaxation offered by spinal anesthesia. Obese patients (with BMI >30 kg/m^2) in whom a potentially higher intra-abdominal pressure is needed were excluded from our study to avoid probable technical difficulties.[16]

Another concern was the consequence of paralyzing the primary expiratory muscles, those of the anterior abdominal wall. In patients without respiratory disease, this would be expected to have little consequence, and the target level of achieving block until T4 is routinely used in other surgeries also like in cesarean section, without any respiratory embarrassment. All 29 patients remained conscious throughout the surgery with no respiratory depression and none complained of any dyspnea. 12 patients displayed tachypnea indicating physiological adaptation of ventilation to increased demand due to CO_2 pneumoperitoneum.[17] Cardiovascular changes were minimal probably the limitation of sympathetic blockade due to segmental blockade was the key factor.

Bessa *et al*.[18] performed laparoscopic cholecystectomy in 180 patients under either spinal anesthesia or under GA, all patients of spinal anesthesia group were discharged on the same day whereas overnight stay was required in 8 patients (8.9%) in the GA group.

Conclusion

This study showed that thoracic combined spinal anesthesia can be used successfully and effectively for laparoscopic cholecystectomy in ASA I and II patients. However, this technique must be used by anesthesiologists with considerable experience of thoracic regional anesthesia. The occurrence of shoulder pain was the main drawback for using regional anesthesia in laparoscopic cholecystectomy but this can be managed effectively with small doses of opioid analgesics.

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